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Synthesis of Novel 3D Covalent Solids by Direct Elementary Reactions at High Pressures and Temperatures * C. S. YOO, H. CYNN, LLNL, M. NICOL, UCLA- Novel materials composed of the first- and second-row elements often exhibit covalently bonded three-dimensional network structures as in the cases of diamond and cubic boron nitride. As the network structure commonly occurs at high pressures, many of such covalently bonded 3D solids can be made directly from the elements at high pressures and temperatures. In this paper, we report highly exothermic direct reactions between boron and nitrogen at high pressures and temperatures yielding technologically important forms of hexagonal and cubic boron nitride. The crystal structures of the boron-nitrogen reaction products vary with pressure. Below 10 GPa, hexagonal BN is the product; cubic or wurzite BN forms at higher pressures. Under nitrogen-rich conditions, another hexagonal allotrope occurs; this seems to be a new highly transparent, low density *h'*-BN. No direct reactions occur at ambient temperature even at pressures as high as 50 GPa, implying that a large activation barrier limits the kinetics of these exothermic processes. Direct reactions between other elements like carbon and oxygen are also discussed.

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